Available online at www.sciencedirect.com
ScienceDirect
Journal of Hydrodynamics
2011,23(4):431-438
DOI: 10.1016/S1001-6058(10)60133-3
www.sciencedirect.com/science/journal/10016058

EXPERIMENTAL STUDY AND MODELING OF PRESSURE LOSS FOR FOAM-CUTTINGS MIXTURE FLOW IN HORIZONTAL PIPE*

AMNA Gumati, HIROSHI Takahshi
Graduate School of Environmental Studies, Tohoku University, 6-6-20 Aramaki-Aza-Aoba, Aoba-ku, Sendai 980-8579, Japan, E-mail: amna@algumati.com

(Received May 26, 2010, Revised May 19, 2011)

Abstract: In this study, we first sought to elucidate foam rheology to describe foam flow behavior, and then to experimentally investigate the pressure losses for both foam and foam-cuttings flow in a horizontal pipe by considering both varied foam qualities of 80%, 85% and 90% and foam velocities. Also, a two-layer numerical model to predict pressure loss was developed based on experimental observations of cuttings behavior. Results show that the foam behaves like a power-law fluid. Furthermore, and the pressure loss significantly increases as foam velocity increases, while the delivered cuttings concentration dramatically decreases. Moreover, results indicate that both the pressure loss and the delivered cuttings concentration increase with foam quality. Comparisons between the experimental results and numerical model predictions show satisfactory agreement.

Key words: foam rheology, pressure loss, horizontal pipe, cuttings concentration, two-layer model

Introduction

Foam has been used in many applications in the oil and gas industry, especially in underbalanced drilling, where the pressure of drilling fluid is kept at a value smaller than the formation pore pressure. Foam has been proved to be a strong candidate as a drilling fluid in underbalanced drilling because of its variable density and good cuttings transport ability. Additionally, in many field cases, foam has been shown to provide significant benefits, including reduction of operational difficulties such as stuck pipe, loss of fluid circulation, minimization of formation damage and an increase in drilling rate[1].

Foam is defined as a large volume of gas dispersed in a small volume of liquid containing a foaming agent (surfactant), where the continuous phase is liquid and the discrete phase is gas. Foam is classified according to its quality, which is defined as gas volume ratio to the total volume of foam, and foam is characterized into dry and wet foam according to its texture, i.e., the bubble size and bubble size distribution. To achieve successful drilling operations under underbalanced conditions, foam rheology, pressure loss and cuttings transport behavior should be fully understood to minimize the risks and costs associated with foam drilling, especially in horizontal foam drilling.

In literature, different studies of rheological foam flow behavior have been reported in recent years to model the rheological characterization of foam, but there is disagreement among researchers to select the best model for describing the foam flow behavior[2]. This is mainly because of the complexity of foam and the differences of analytical approaches and experimental setups. Basically, two different approaches for characterizing foam rheology have been reported: (1) quality-based method and (2) volume equalized method. In the quality-based approach, foam is treated as a single phase fluid and it is characterized separately for different foam qualities, while in the volume equalized approach, foam normalizes the quality values and it is characterized by using parameters valid for all quality values[3].

Moreover, the determination of pressure loss has also been found to be a very important aspect in horizontal foam drilling[4]. Therefore, appropriate measurement of pressure loss is one of the key features of a successful underbalanced operation. Furthermore, a better understanding of cuttings transport with foam is important for accurate prediction of pressure losses

* **Biography:** AMNA Gumati (1976-), Female, Ph. D.